cosylab
CONTROL SYSTEM LABORATORY

Java implementation of Channel Access (CAJ)

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What is CAJ?

- **C**hannel **A**ccess in **J**ava (CAJ) is a CA client library written completely in Java
- It “plugs” into JCA 2 interfaces
- Written as a result of detailed analysis of existing CA library to provide better *stability* and *performance* opposed to the current JCA JNI implementation
- Since it was written from scratch code is clean, follows OO design and uses lots of design patterns
- No problems with native libraries (no recompilation needed)

Achieving stability

- The main reason CAJ was written is stability - JCA JNI was not hard to crash with our ControlDesk application for the DLS (extensive concurrent connect, monitor creation and value retrieval)
- Profound testing during the whole development cycle
  - ~ 90% of code coverage!
- Code simplicity helped a lot (simple code leads to less bugs)
- ‘TCP Reno’-like UDP congestion control
- Until now “only” 3 CAJ bugs were discovered
  - 2 by Ken Evans

Achieving performance

- Latest concurrent, network communication design patterns used to implement efficient event demultiplexing, minimize context switching and maximize CPU cache affinity (Leader/Followers design pattern used)
- Asynchronous I/O used (Java NIO package)
    - new epoll-based selector supported, which is improved select(); available in the latest Linux 2.6 kernel
- (Some performance measurements will be shown later)

- Due to OO design light CAJ version is possible (one communication thread), convenient for light CA clients (handhelds)

Immediate JCA JNI to CAJ migration

Simply change (example):

```
jca.createContext(JCALibrary.JNI_SINGLE_THREADED);
                              OR
jca.createContext(JCALibrary.JNI_THREAD_SAFE);
```

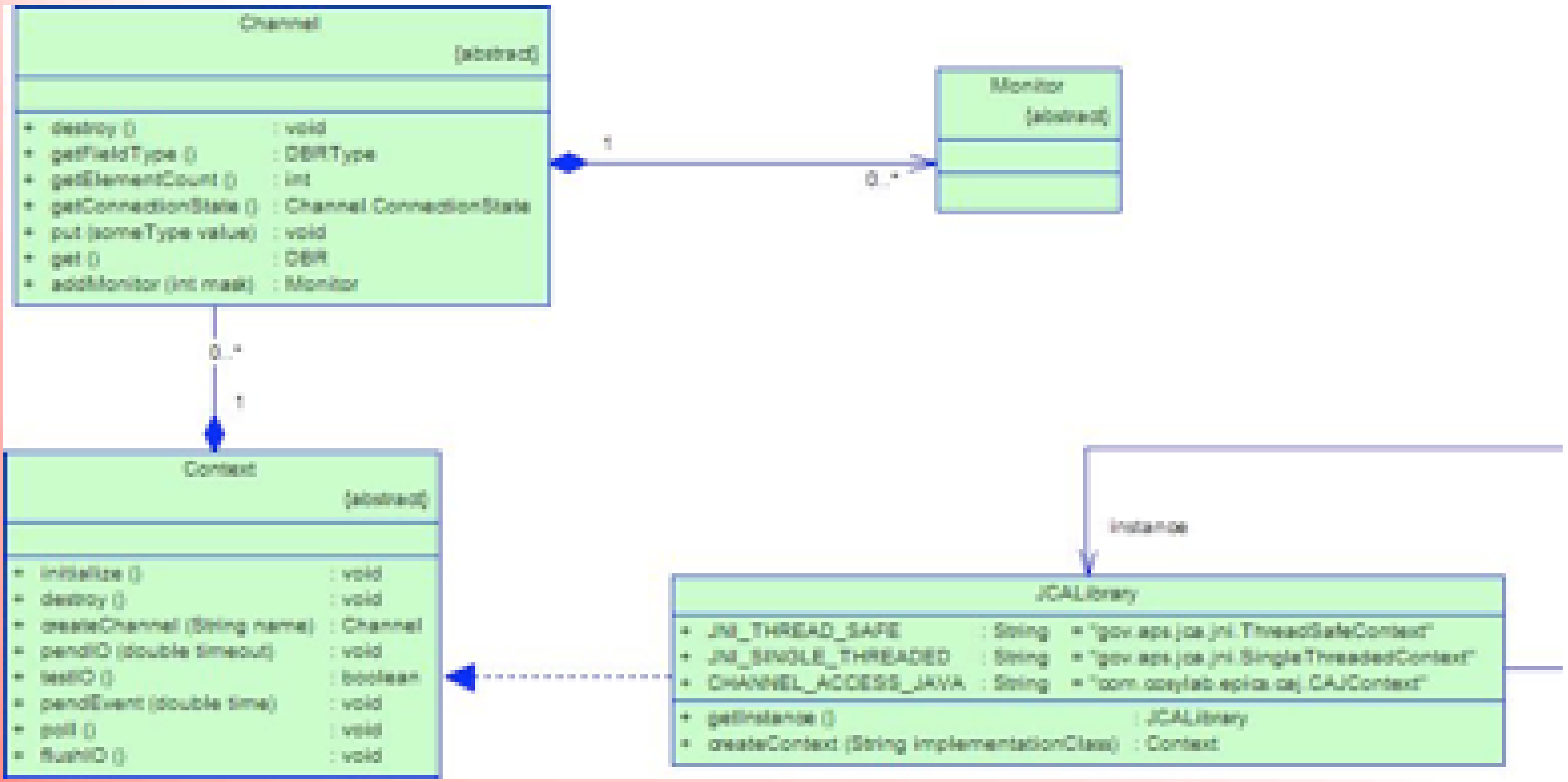
↓

```
jca.createContext(JCALibrary.CHANNEL_ACCESS_JAVA);
```

… and take care of configuration.

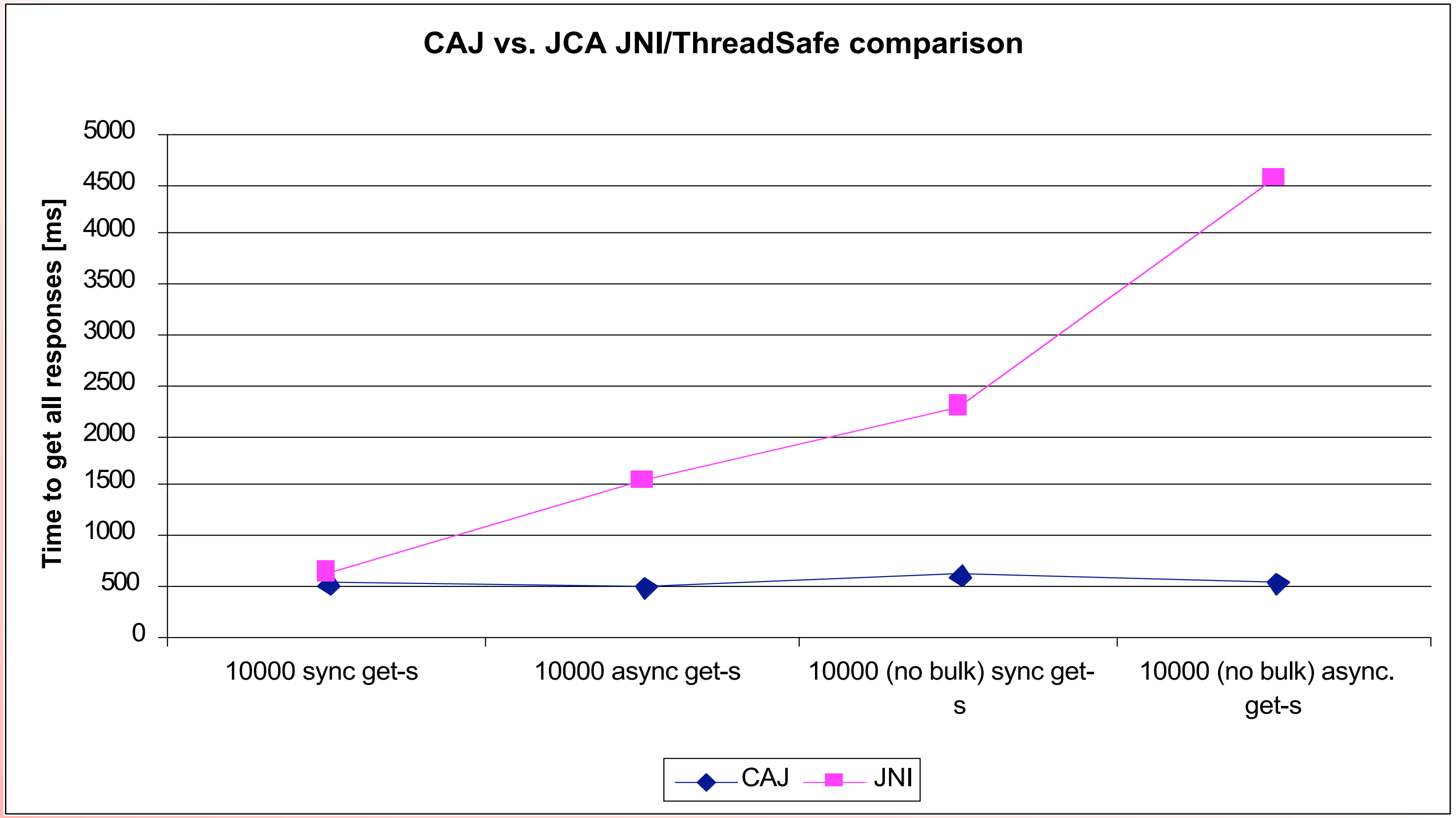
Note that CAJ can not use system environment variables like `EPICS_CA_ADDR_LIST` (not available in Java 1.4, but available again in Java 1.5).

OO Usage of JCA


Channel
[abstract]
+ destroy () : void
+ getFieldType () : DBRType
+ getElementCount () : int
+ getConnectionState () : Channel.ConnectionState
+ put (someType value) : void
+ get () : DBR
+ addMonitor (int mask) : Monitor
1
0..*
Monitor
[abstract]
0..*
1
Context
[abstract]
+ initialize () : void
+ destroy () : void
+ createChannel (String name) : Channel
+ pendIO (double timeout) : void
+ testIO () : boolean
+ pendEvent (double time) : void
+ poll () : void
+ flushIO () : void
instance
JCALibrary
+ JNI_THREAD_SAFE : String = "gov.aps.jca.jni.ThreadSafeContext"
+ JNI_SINGLE_THREADED : String = "gov.aps.jca.jni.SingleThreadedContext"
+ CHANNEL_ACCESS_JAVA : String = "com.cosylab.epics.caj.CAJContext"
+ getInstance () : JCALibrary
+ createContext (String implementationClass) : Context

Performance measurements

- Client on the same host as server, Pentium IV 1.6GHz, 1GB RAM, Red Hat 9
- "no bulk" means calling flushIO() after each get request



Note: this is only synthetic performance test and doesn't reflect performance in practice!

Comparing to C Version of CA

- Completely different approaches:
    - C pointer versus Java object creation
    - Java is clean, C is dirty but quick ☺
- Based on CA 4.11, should be compabitle down to 4.0
    - But has not been tested
- Backward compatibility might be an issue
    - several undocumented features in the C version, might have missed one

User Experiences

- Control Desk
  - was limited to some 300 PVs before
- JoiMint
  - just got ported to JCA 2 so it can use CAJ
- JProbe (Ken Evans ported it to JCA 2).
  - "I have tested it on all the dbr types. Like my performance test, it is an application that requires a large subset of the features provided by CA. I think CAJ is looking good."
  - "Moreover, my test program, which accesses 100 PVs updating at 10 Hz, worked *much* better. Before, there were dropouts. Now, it seems to keep up. Cool!"

Conclusions

- Needs some time (production usage) to confirm maturity
- JCA still has much room for performance improvements, now that JNI isn’t the bottleneck anymore
- Open possiblities for more user friendly applications based on Java
  - develop a CAJ server to integrate other Java Applications?
- Proves that
  - other-than legacy CA implementation can be done …
  - CA documentation is useful and useable and that CA is not something mysterious
- Cosylab needs a new task (and funding ☺)